

Appl. No: 10/710,928
Amdt. dated March 15, 2005
Reply to Office action of December 15, 2004

Amendments to the Specification:

Please replace paragraph [0002] with the following amended paragraph:

- 5 [0002] The invention relates to a light emitting diode package, and more particularly, to a light emitting diode package having ~~scatterer~~ scatter-supported wavelength converters embedded in a molding material and having superior illumination uniformity and manufacturing convenience.

- 10 **Please replace paragraph [0006] with the following amended paragraph:**

- [0006] Please refer to Fig.1. Fig.1 is a schematic diagram of a prior art lead type light emitting diode package 10. As shown in Fig.1, the prior art lead type light emitting diode package 10 comprises a light emitting diode chip 12, a mount lead 14,
15 and an inner lead 16. The mount lead 14 further comprises a cup 18. The mount lead 14 is used as a negative electrode, and the inner lead 16 is used as a positive electrode. The light emitting diode chip 12 is disposed in the cup 18 of the mount lead 14. A P electrode and an N electrode (both are not shown in the figure) of the light emitting diode chip 12 are connected to the mount lead 14 and the inner lead 16, respectively,
20 by conductive wires 22. The cup 18 is filled with a molding material 24 for encapsulation. A plurality of fluorescent materials (not shown) are spread in the molding material 24.

Please replace paragraph [0008] with the following amended paragraph:

- 25 [0008] Please refer to Fig.2. Fig.2 is a schematic diagram of a prior art chip type light emitting diode package 50. As shown in Fig.2, the prior art chip type light emitting diode package 50 comprises a light emitting diode chip 52 and a casing 54.

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The casing 54 further comprises a positive metal terminal 56 and a negative metal terminal 58. The positive metal terminal 56 is used as a positive electrode, and the negative metal terminal 58 is used as a negative electrode. The light emitting diode chip 52 is disposed in a recess 62 of the casing 54 and is on top of the positive metal terminal 56. A P electrode and an N electrode (both are not shown in the figure) of the light emitting diode chip 52 are connected to the positive metal terminal 56 and the negative metal terminal 58, respectively, by conductive wires 64. The recess 62 is filled with a molding material 66 for encapsulation. A plurality of fluorescent materials (not shown) are spread in the molding material 66.

Please replace paragraphs [0014] and [0015] with the following amended paragraphs:

[0014] According to the claimed invention, a lead type light emitting diode package is disclosed. The lead type light emitting diode package comprises a light emitting diode device disposed in the lead type light emitting diode package, and a molding material covering the light emitting diode device. A plurality of scatterer ~~scatter~~ supported wavelength converters are included in the molding material. Portions of light beams emitted from the light emitting diode device incident to each of the scatterer ~~scatter~~ supported wavelength converters are scattered by each of the scatterer ~~scatter~~ supported wavelength converters, and portions of light beams emitted from the light emitting diode device incident to each of the scatterer ~~scatter~~ supported wavelength converters are absorbed to excite each of the scatterer ~~scatter~~ supported wavelength converters to emit light in another wavelength.

[0015] The present invention light emitting diode package embeds scatterer ~~scatter~~ supported wavelength converters in the molding material, and each of the scatterer ~~scatter~~ supported wavelength converters is a composite unit of the wavelength converting activator and the scatterer. The inhomogeneous phenomenon occurring

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during the mixing procedure is thus avoided because the problem that different material particles have different weights, different shapes, different physical properties, and different chemical properties does not exist any more. Therefore, not only are the
5 satisfactory whole tone homogeneity and brightness uniformity achieved, but also the molding material embedded with the scatterer ~~scatter~~-supported wavelength converters can be applied to various package structures. In addition, the manufacturing convenience is kept when performing packaging process so that processing complexity is not increased. Furthermore, the light emitting diode chip may be fixed
10 on the high reflectivity surface in the present invention light emitting diode package by utilizing a non-conductive adhesive highly permeable to light to improve the amount of illumination of the front surface. Moreover, the light emitting diode chip and the diode chip may be anti in parallel with each other to achieve the objective of electrostatic charge protection.

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Please replace paragraphs [0019]-[0021] with the following amended paragraphs:

[0019] Fig.3 is a schematic diagram of a scatterer ~~scatter~~-supported wavelength converter according to a first preferred embodiment of the present invention.

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[0020] Fig.4 is a schematic diagram of a scatterer ~~scatter~~-supported wavelength converter according to a second preferred embodiment of the present invention.

[0021] Fig.5 is a schematic diagram of a scatterer ~~scatter~~-supported wavelength converter according to a third preferred embodiment of the present invention.

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Please replace paragraphs [0026]-[0035] with the following amended paragraphs:

[0026] Please refer to Fig.3. Fig.3 is a schematic diagram of a scatterer ~~scatter~~-

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supported wavelength converter 100 according to a first preferred embodiment of the present invention. As shown in Fig.3, the present invention ~~scatterer seatter~~-supported wavelength converter 100 is a physical composite material or a chemical composite material. The ~~scatterer seatter~~-supported wavelength converter 100 comprises a scatterer 102 and a plurality of wavelength converting activators 104 having a physical or chemical bonding therebetween. Each of the wavelength converting activators 104 adheres to portions of a surface of the scatterer 102. The wavelength converting activator 104 is a wavelength converting material, and the scatterer 102 is a scattering material for repetitively scattering and diffusing light beams. In addition, different phases may exist in the interface between the phase of the scatterer 102 and the phase each of the wavelength converting activator ~~activators-104~~.

[0027] Please refer to Fig.4. Fig.4 is a schematic diagram of a ~~scatterer seatter~~-supported wavelength converter 200 according to a second preferred embodiment of the present invention. As shown in Fig.4, the present invention ~~scatterer seatter~~-supported wavelength converter 200 is a physical composite material or a chemical composite material. The ~~scatterer seatter~~-supported wavelength converter 200 comprises a scatterer 202 and a wavelength converting activator 204 having a physical or chemical bonding therebetween. The scatterer 202 is encapsulated by the wavelength converting activator 204. The wavelength converting activator 204 is a wavelength converting material, and the scatterer 202 is a scattering material for repetitively scattering and diffusing light beams. In addition, different phases may exist in the interface between the phase of the scatterer 202 and the phase of the wavelength converting activator 204.

[0028] Please refer to Fig.5. Fig.5 is a schematic diagram of a ~~scatterer seatter~~-supported wavelength converter 300 according to a third preferred embodiment of the present invention. As shown in Fig.5, the present invention ~~scatterer seatter~~-supported wavelength converter 300 is a physical composite material or a chemical composite material. The ~~scatterer seatter~~-supported wavelength converter 300 comprises a scatterer 302 and a plurality of wavelength converting activators 304 having a

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physical or chemical bonding therebetween. Each of the wavelength converting activators 304 is spread in the scatterer 302. The wavelength converting activator 304 is a wavelength converting material, and the scatterer 302 is a scattering material for
 5 repetitively scattering and diffusing light beams. In addition, different phases may exist in the interface between the phase of the scatterer 302 and the phase each of the wavelength converting activator ~~activators~~-304.

[0029] The wavelength converting activators 104, 204, 304 in the first, second, and
 10 third preferred embodiments of the present invention are all materials represented by a general formula $(Y, Ce, Tb, Gd, Sc)_{3+t+u}(Al, Ga, Ti, In, B)_{5+u+2v}(O, S, Se)_{12+2t+3u+3v}$:
 (Ce, Tb)(where $0 < t < 5$, $0 < u < 15$, $0 < v < 9$). All of the scatterers 102, 202, 302 comprise
 an oxide, a sulphuret, or a selenium compound of at least one metal element selected
 from the above general formula. In fact, the present invention wavelength converting
 15 activators 104, 204, 304 and scatterers 102, 202, 302 are not limited to the
 above-mentioned materials. Any material having good wavelength converting
 characteristics and any material having a good scattering effect, which can be
 physically mixed to each other successfully or chemically combined together
 successfully to form the above-mentioned scatterer ~~scatter~~-supported wavelength
 20 converters 100, 200, 300 are within the scope of the present invention. In addition, the
 wavelength converting activator of each of the scatterer ~~scatter~~-supported wavelength
 converters 100, 200, 300 is not limited to one single material, and the scatterer of each
 of the scatterer ~~scatter~~-supported wavelength converters 100, 200, 300 is not limited to
 one single material too. That means, the present invention scatterer ~~scatter~~-supported
 25 wavelength converter may be a composite material composed of a plurality kinds of
 wavelength converting activators and one kind of scatterer, one kind of wavelength
 converting activator and a plurality kinds of scatterers, or a plurality kinds of
 wavelength converting activators and a plurality kinds of scatterers.

[0030] In the present invention, each of the scatterer ~~scatter~~-supported wavelength
 30 converters 100, 200, 300 is mixed in a molding material. In addition, each individual
scatterer ~~scatter~~-supported wavelength converter 100, 200, 300 is a composite unit, as

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an integral particle, of the wavelength converting activator 104, 204, 304 and the scatterer 102, 202, 302, respectively. Therefore, the problem that different material particles have different weights, different shapes, different physical properties, and different chemical properties no longer exists for avoiding the inhomogeneous mixing phenomenon when performing the mixing procedure. It is worth noting that the molding material comprises an organic molding compound, a ceramic material permeable to light, a glass material permeable to light, an insulation fluid material permeable to light, or a composite material comprising at least two materials selected from a group consisting of the above-mentioned materials.

[0031] Please refer to Fig.6. Fig.6 is a schematic diagram of a present invention lead type light emitting diode package 400. As shown in Fig.4, the present invention lead type light emitting diode package 400 comprises a light emitting diode chip 402, a mount lead 404, and an inner lead 406. The mount lead 404 further comprises a cup 408. The mount lead 404 is used as a negative electrode, and the inner lead 406 is used as a positive electrode. The light emitting diode chip 402 is disposed in the cup 408 of the mount lead 404. A P electrode and an N electrode (both are not shown in the figure) of the light emitting diode chip 402 are connected to the mount lead 404 and the inner lead 406, respectively, by conductive wires 412. The cup 408 is filled with a molding material 414 for encapsulation. A plurality of ~~scatterer~~ scatter-supported wavelength converters (not shown) are spread in the molding material 414. The ~~scatterer~~ scatter-supported wavelength converters may be any kind of ~~scatterer~~ scatter-supported wavelength converter disclosed in the present invention.

[0032] When light beams are emitted from the light emitting diode chip 402 and pass through the molding material 414, portions of the light beams are absorbed by the wavelength converting activators (not shown) of the ~~scatterer~~ scatter-supported wavelength converters to excite one or more than one wavelength converting materials such that light beams in another wavelength are generated (to convert blue light beams into yellow light beams). At the same time, portions of the light beams are repetitively scattered and diffused by the scatterers (not shown) of the ~~scatterer~~ scatter-

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supported wavelength converters to inhibit the light beams from having abrupt intensity. Finally, the above-mentioned light beams will mix with the light beams emitted from the light emitting diode chip 402 and are not converted at all to emit
5 light beams of white color or another color. Since the ~~scatterer~~ ~~scatter~~-supported wavelength converters are spread in the molding material 414 very evenly according to the present invention, the white light beams generated at last will have very superior tone homogeneity and brightness uniformity.

10 [0033] Please refer to Fig.7. Fig.7 is a schematic diagram of a present invention chip type light emitting diode package 500. As shown in Fig.7, the present invention chip type light emitting diode package 500 comprises a light emitting diode chip 502 and a casing 504. The casing 504 further comprises a positive metal terminal 506 and a negative metal terminal 508. The positive metal terminal 506 is used as a positive
15 electrode, and the negative metal terminal 508 is used as a negative electrode. The light emitting diode chip 502 is disposed in a recess 512 of the casing 504 and is on top of the positive metal terminal 506. A P electrode and an N electrode (both are not shown in the figure) of the light emitting diode chip 502 are connected to the positive metal terminal 506 and the negative metal terminal 508, respectively, by conductive
20 wires 514. The recess 512 is filled with a molding material 516 for encapsulation. A plurality of ~~scatterer~~ ~~scatter~~-supported wavelength converters (not shown) are spread in the molding material 516. The ~~scatterer~~ ~~scatter~~-supported wavelength converters may be any kind of ~~scatterer~~ ~~scatter~~-supported wavelength converter disclosed in the present invention.

25 [0034] When light beams are emitted from the light emitting diode chip 502 and pass through the molding material 516, portions of the light beams are absorbed by the wavelength converting activators (not shown) of the ~~scatterer~~ ~~scatter~~-supported wavelength converters to excite one or more than one wavelength converting
30 materials such that light beams in another wavelength are generated (to convert blue light beams into yellow light beams). At the same time, portions of the light beams are repetitively scattered and diffused by the scatterers (not shown) of the ~~scatterer~~ ~~scatter~~-

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supported wavelength converters to inhibit the light beams from having abrupt intensity. Finally, the above-mentioned light beams will mix with the light beams emitted from the light emitting diode chip 502 and are not converted at all to emit
5 light beams of white color or another color. Since the ~~scatterer~~ ~~scatter~~-supported wavelength converters are spread in the molding material 516 very evenly according to the present invention, the white light beams generated at last will have very superior whole tone homogeneity and brightness uniformity.

10 [0035] Since an LED itself tends to accumulate unexpected charges, electrostatic charges are thus generated. When a reverse biased voltage is applied on the LED, a punch through phenomenon occurs frequently. Due to the poor electrostatic charge protection ability of the LED, the LED is usually anti in parallel with a diode to improve the electrostatic charge protection ability of the LED. Please refer to Fig.8.
15 Fig.8 is a schematic diagram of a present invention lead type light emitting diode package 600 having a light emitting diode chip 602 anti in parallel with a diode chip 624. As shown in Fig.8, the present invention lead type light emitting diode package 600 comprises a light emitting diode chip 602, a mount lead 604, and an inner lead 606. The mount lead 604 further comprises a cup 608. The mount lead 604 is used as a
20 negative electrode, and the inner lead 606 is used as a positive electrode. The light emitting diode chip 602 is not disposed on the mount lead 604 and the inner lead 606 (in other words, not disposed on the positive electrode and the negative electrode). Oppositely, the light emitting diode chip 602 is adhered to a high reflectivity surface 622 in the lead type light emitting diode package 600 by a non-conductive adhesive
25 618 permeable to light. When light beams are emitted from the light emitting diode chip 602, the light beams emitted downwards will first pass the non-conductive adhesive 618 permeable to light, and then are reflected by the high reflectivity surface 622. After that, the light beams optically react with wavelength converting activators and scatterers of ~~scatterer~~ ~~scatter~~-supported wavelength converters (all are not shown
30 in the figure). Therefore, the amount of front illumination of the light emitting diode chip 602 is improved to improve the brightness of the lead type light emitting diode package 600. In addition, two slant surfaces (not shown) may be disposed on the high

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reflectivity surface 622 to further improve the amount of illumination.

Please replace paragraph [0037] with the following amended paragraph:

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[0037] Please refer to Fig.9. Fig.9 is a schematic diagram of a present invention chip type light emitting diode package 700 having a light emitting diode chip 702 anti in parallel with a diode chip 724. As shown in Fig.9, the present invention chip type light emitting diode package 700 comprises a light emitting diode chip 702 and a casing 704. The casing 704 further comprises a positive metal terminal 706 and a negative metal terminal 708. The positive metal terminal 706 is used as a positive electrode, and the negative metal terminal 708 is used as a negative electrode. The light emitting diode chip 702 is disposed in a recess 712 of the casing 704 and is not on top of the positive metal terminal 706 and the negative metal terminal 708 (in other words, not disposed on the positive electrode and the negative electrode). Oppositely, the light emitting diode chip 702 is adhered to a high reflectivity surface 722 in the chip type light emitting diode package 700 by a non-conductive adhesive 718 permeable to light. When light beams are emitted from the light emitting diode chip 702, the light beams emitted downwards will first pass the non-conductive adhesive 718 permeable to light, and then are reflected by the high reflectivity surface 722. After that, the light beams optically react with wavelength converting activators and scatterers of ~~scatterer~~ scatter-supported wavelength converters (all are not shown in the figure). Therefore, the amount of front illumination of the light emitting diode chip 702 is improved to improve the brightness of the chip type light emitting diode package 700.

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Please replace paragraphs [0039]-[41] with the following amended paragraphs:

[0039] It is worth noting that both the diode chips 624, 724, in coordination with the light emitting diode chips 602, 702 in Fig.8 and Fig.9, comprises a common diode chip, a Zenar diode chip, a Schotkey diode chip, or a Transient Voltage Suppressor diode chip. In addition, blue fluorescent powders may be added into the molding

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material to absorb light beams having short wavelengths (395-450nm) to emit blue light beams and excite ~~scatterer~~ ~~scatter~~-supported wavelength converters to emit yellow light beams. After mixing the light beams, light beams of white color or
5 another color are generated. Under the circumstances, the light efficiency is further improved.

[0040] The present invention light emitting diode package embeds ~~scatterer~~ ~~scatter~~-supported wavelength converters in the molding material, and each of the ~~scatterer~~
10 ~~scatter~~-supported wavelength converters is a composite unit of the wavelength converting activator and the scatterer. Therefore, the inhomogeneous mixing phenomenon occurring during the mixing procedure is effectively avoided. When applying the present invention light emitting diode package to a practical production line, products having good whole tone homogeneity, high brightness, and high
15 electrostatic charge protection ability are produced.

[0041] In contrast to the prior art light emitting diode package, the present invention light emitting diode package embeds ~~scatterer~~ ~~scatter~~-supported wavelength converters in the molding material, and each of the ~~scatterer~~ ~~scatter~~-supported
20 wavelength converters is a composite unit of the wavelength converting activator and the scatterer. The inhomogeneous phenomenon occurring during the mixing procedure is thus avoided because the problem that different material particles have different weights, different shapes, different physical properties, and different chemical properties does not exist any more. Not only are the satisfactory whole tone
25 homogeneity and brightness uniformity achieved, but also the molding material embedded with the ~~scatterer~~ ~~scatter~~-supported wavelength converters can be applied to various package structures. In addition, the manufacturing convenience is kept when performing packaging process so that processing complexity is not increased. Furthermore, the light emitting diode chip may be fixed on the high reflectivity
30 surface in the present invention light emitting diode package by utilizing a non-conductive adhesive highly permeable to light to improve the amount of illumination of the front surface. Moreover, the light emitting diode chip and the diode

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chip may be anti in parallel with each other to achieve the objective of electrostatic charge protection.

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